

NUCLEAR PHYSICS

Neutron Becomes Proton

Reverse action is also found in atom nucleus showing how the nucleus is held together by a subnuclear force differing from any known forces.

See Front Cover

► THE neutron (trigger of the atomic bomb and the proton (heart of the hydrogen atom), both fundamental particles in the nuclei of atoms, can turn one into the other.

This top discovery in man's invasion of the atomic nucleus was announced by Prof. Ernest O. Lawrence, Nobel physicist of the University of California, who delivered the first Silliman lecture of Yale's Centennial Celebration of the Sheffield Scientific School at New Haven, Conn.

This research done with the new giant cyclotron at Berkeley gives direct evidence on the nature of the force that holds the nucleus together. It confirms for the first time a basic theory of atomic forces proposed by the German Dr. Werner Heisenberg in the early 1930's. Dr. Heisenberg headed Nazi atomic energy research during the war.

A new monster atom-smashing "bevatron" to attain 10 billion electron volts was also shown in preliminary design by Prof. Lawrence.

This Heisenberg theory, now confirmed, explained an anomaly of the nucleus. The elementary particles of the nucleus are protons, with a positive electrical charge, and neutrons, with no charge. If electrical laws alone were considered, the nucleus could not exist because protons would repel each other so forcibly when packed together in the nucleus that the atom would disintegrate.

Exchange Forces in Nucleus

Dr. Heisenberg proposed that, in addition to ordinary forces, there are "exchange forces" acting within the nucleus. For example, the charge on the proton, the theory holds, is tossed back and forth between the proton and neutrons, creating a subnuclear force differing from any known forces.

Prof. Lawrence said experiments at Berkeley proving this to be true were done by Drs. B. J. Moyer, J. Hadley, C. E. Leith, Harvey York and Wilson Powell. Interpretation of the results was done largely by Prof. Robert Serber and

the theoretical staff of the Radiation Laboratory.

Two types of experiments were done, using the 100-million electron volt neutrons which are emitted from a target of beryllium bombarded by 200-million electron volt deuterons, the nuclei of heavy hydrogen atoms.

In the first experiment, the high energy neutrons were turned on a target of paraffin, which contains many atoms of hydrogen, the simplest of all nuclei, consisting of one proton.

Like Billiard Ball Collision

Prof. Lawrence likened this situation to a billiard ball collision. He said that the frequency with which the "cue ball" neutrons would strike the target protons a glancing blow and then continue at a slight angle in the same general direction can be calculated according to the laws of probability.

At varying angles away from the paraffin target a series of four radiation counters were placed, weak radiations being filtered out by the first three counters.

It was found that high energy protons were being emitted where ordinary mechanical laws would dictate that only neutrons could be.

The conclusion, Prof. Lawrence said, is that the neutrons, in the collisions, had picked up the charge of the protons. In Jekyll-and-Hyde fashion, the neutrons had become protons and the protons neutrons.

Cloud chamber photographs taken by Dr. Powell revealed the same thing. Neutrons cannot be photographed in a cloud chamber, but protons can. Protons suddenly starting up in the photographs took the same pattern of angles from the direction of neutron beam as they did in the other experiment. Thus it was concluded that the bombarding neutrons had been converted into protons in an exchange of charge.

The pictorial record of the latest advance in physics, appearing on this week's cover of the SCIENCE NEWS LETTER, is a cloud chamber photograph showing the disintegration of carbon and oxygen



MELTED BY RADIO—The investigator shown is measuring the temperature of thorium with a pyrometer while radio waves bombard it in a tubular high frequency melting chamber of the Westinghouse Lamp Research Laboratories. Thorium powder fuses at 3,600 degrees Fahrenheit.

nuclei and the conversion of neutrons into protons under bombardment of 100 million electron volt neutrons from the giant University of California cyclotron.

Direction of the neutron beam is indicated by the arrow. Four "stars," the disintegrations of nuclei similar to those found in cosmic rays, are lined up in a row from a point directly to the right of the arrow to the right of the picture. The heavy tracks are made by alpha particles and protons emitted from the disintegrations. The long curving track is a 1.8 million electron volt proton.

Conversion of a neutron into a proton, demonstrated for the first time, is seen in three short tracks: first just above the right of the arrow; second, halfway between the second and third "stars"; and third, just to the right of the third star and crossing one of the tracks of that star.

Curvature of the tracks was produced by a magnetic field of 13,000 gauss.

For 15 years scientists have been trying unsuccessfully to prove Heisenberg's hypothesis. Low-energy cyclotrons did not give collision phenomena of sharp enough definition for conclusive proof.

Billions of Electron Volts

Prof. Lawrence said that the "bevatron" would have a magnet weighing 13,000 tons, and that its source of protons would be a Van de Graaff generator.

"Developments in atomic physics have been and are continuing to be so rapid and so fundamental in character as to